TABLET TOUCHTUTOR®: A 21ST-CENTURY OFFLINE TOOL TO ENHANCE THE SELF-DIRECTED LEARNING OF FET MATHEMATICS LEARNERS

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ABSTRACT:
The comparatively low 58% pass rate of the 2018 grade 12 Mathematics learners, the below average performance in the Trends in International Mathematics and Science Study (TIMSS) and the Annual National Assessments (ANA) indicate several challenges in school Mathematics teaching and learning in South Africa. Reasons for the low performance include the inferior content knowledge levels of some teachers and the lack of self-directed learning (SDL) amongst learners. The use of effective blended learning has also lacked behind, particularly in quintiles 1-3 schools. Using constructivist and cooperative learning environments outside the normal classroom as the theoretical framework and following a quantitative-qualitative methodology, with the aim to support the classroom activities and enhance SDL, the TouchTutor® Mathematics resource package and the Saturday Incubator Support Programme (ISP) were implemented in the Eastern Cape Province in 2018. Selected grades 11 and 12 learners were supported over sixteen (16) alternate Saturdays. With the TouchTutor®'s interactive digital resources installed in Android Tablets, learners had 24/7 offline access to a range of curriculum-aligned support materials during and between ISP sessions. This paper reports the learning impact and ISP experiences of the learners with the TouchTutor® Mathematics package, as readily accessible, enjoyable, motivating, inspiring, actively engaging, thereby enhancing SDL and improving the performance of learners.

Key words: TouchTutor®; techno-blended model; self-directed learning; 24/7 offline access; Incubator Support Programme.

INTRODUCTION

Of all the 2018 National Senior Certificate (NSC) examination school subjects, Mathematics has the second lowest pass rate of 58% after Technical Mathematics with 50.7% (DBE, 2019). The Mathematics pass rate has been below 60% for more than a decade. Only in 2018, since the introduction of Technical Mathematics, has the mathematics pass rate been better than that of any other NSC subject.

The relatively poor Mathematics performance robs South Africa of the required number of learners who proceed to study engineering, actuarial science and other Mathematics requiring qualifications at tertiary institution. The consequences are fewer than required graduates to fill the available positions and shortage of skilled personnel to drive the relevant economic sector(s) to influence the Gross Domestic Product (GDP) of the country positively.

The low Mathematics results point to challenges in Mathematics education throughout the basic education sector in South Africa (SA) (DBE, 2019; Collet & Steyn, 2017). Amongst Mathematics learners, challenges include their lack of interest and self-directed learning (SDL), low confidence, inability to learn at the levels that they are taught at, and significant content knowledge gaps (Olivier, 2016). Amongst teachers, challenges include lack of confidence and skills of many to effectively teach the Mathematics curriculum, and widespread reliance of many on traditional teacher-centered pedagogies (Olivier, 2016; Collet & Steyn, 2017:455). The lack of quality teaching and learning resource materials for the 21st century classrooms is also a contributing factor (Collet & Steyn, 2017:455; NPC, 2012:302; DBE, 2014; Olivier, 2016).

A TouchTutor® Mathematics resource package and Saturday Incubator Support programme (ISP) Model was introduced in some Eastern Cape Province (ECP) secondary schools in 2018 (and before), to address some of the educational challenges. Developed by the Govan Mbeki Mathematics Development Centre (GMMDC) of the Nelson Mandela University (NMU), the TouchTutor® is based on the integrated use of offline and Mathematics Curriculum and

Assessment Policy Statement (CAPS) aligned interactive digital teaching-learning resource materials (Olivier, 2016 & 2017).

Background and Problem Statement

The TouchTutor® resource package for Mathematics CAPS has many components which include innovative support functions. Included is a series of content video lessons with narration based on graphically enhanced PowerPoints with animations. These resources are supplemented by learner workbooks; interactive multiple choice self-assessment tests with scoring and feedback explanations. Sets of examination revision video series based on past national NSC examinations and memoranda are also included (Olivier, 2018).

A CASIO calculator video series with on-screen emulator demonstrations of how to utilise the scientific calculator adds yet another innovative component to support learning. An integrated curriculum aligned language support functionality is also included to allow the users of the TouchTutor® package to access explanations of Mathematical concepts in English and 7 indigenous South African languages at any time (Olivier, 2018). All of the above are supplemented with guidance and information on Science, Technology, Engineering, Art and Mathematics (STEAM) careers and how to gain access to study programmes at institutions of Higher Education and Training (HET) (Olivier, 2018).

Before implementation in clusters of secondary project schools, an agreement of commitment and active participation was signed between the GMMDC, the management of the schools, the selected learners and their parents. The commitment and participation is for a series of sixteen (16) Saturday ISP sessions of five (5) hours each, from 08h00-13h00, from February to September of the project year (Olivier, 2018). Dedicated in-service Mathematics lead teachers who were trained by the GMMDC facilitated the ISP sessions according to a prescribed educational model and structured programme of sessions (Olivier, 2018). During the period, two and a half (2½) hours of each Saturday is spent on structured grades 11 and 12 Mathematics lessons facilitated through the TouchTutor® Mathematics resource package and according to official school pace setters published by the Department of Basic Education (DBE) (Olivier, 2018).

Being mindful of the low pass rate and the challenges of the South African Mathematics education, the introduction and use of the TouchTutor® raised five main questions regarding the learners:

- What is the impact of the use of the TouchTutor® resource and ISP on learners' SDL regarding,
  - **a)** motivation to do more Mathematics individually;
  - **b)** access to the Mathematics resource material;
  - **c)** mathematical knowledge gained via TouchTutor®;
  - **d)** level of sharing with fellow learners and level of engagement with Mathematics?
- Which TouchTutor® technologies and/or resources were mostly accessed and/or used by the learners between the Saturday ISP sessions to learn Mathematics?
- What are the possible places where the learners would use the TouchTutor® between the Saturday ISP sessions to learn Mathematics?
- How often would the learners access the Mathematics on the TouchTutor® between the Saturday ISP sessions to learn Mathematics?
- What average time in hours, would the learners spent per week with the TouchTutor® between the Saturday ISP sessions to learn Mathematics?

THEORETICAL BACKGROUND

Theoretical / Conceptual framework

The theoretical framework for this study was and still is the establishment of rich, exciting and sustainable constructivist learning environments for Mathematics "in socio-economically challenged school environments" of the under-resourced schools (Olivier, 2018). A modern, innovative, exciting and offline tool called the TouchTutor® based on the integrated use of

digital technologies and Mathematics CAPS resources, was used not only to create the learning environments supporting Mathematics teaching and learning, but also enhance self-directed learning.

The TouchTutor® is a comprehensively Mathematics CAPS-aligned digital resource, techno-blended model available to be used via Android Tablets and phones by learners and laptops by teachers to support and develop the understanding and skills of learners (Olivier, 2017). Using offline rather than online technologies, the TouchTutor® is a new paradigm shift from blended learning, to support Mathematics teaching and learning in South Africa and the developing world. The use of the TouchTutor® during and between 16 Saturday ISP sessions to promote and enhance SDL, represents a conceptual framework for the study, that also influences the way Mathematics is taught and supported at the project schools.

LITERATURE REVIEW

Blended learning is a design that integrates different online technologies with the face-to-face teaching and learning approaches (NWU, 2016). The strengths of the integrated approaches "are blended into a unique learning experience", thereby transforming the structure and approach of the teaching and learning practiced in face-face contact classrooms (NWU, 2016). For this reason, many online learning platforms are available to provide constructivist learning environments to both university students and school learners in many countries, particularly in the developed first world (Olivier, 2018). The effective use of blended learning also satisfies the National Curriculum Statement (NCS) Grades R-12's aim number 6 and is therefore an important tool in the fulfilment of the written and intended curriculum in the policy document.

However, lack of human, material and connectivity related resources in the developing countries like South Africa can partly be blamed for the lack of usage and advancement of online technologies. The specific challenges for blended learning in South Africa's under-resources schools include web-access in terms of service availability and costs involved, technological skills of teachers and security of the Information and Communications Technology (ICT) equipment (Olivier, 2018). Naturally, the challenges become barriers for the integration of ICT support in education if the challenges cannot be overcome and no alternatives to blended learning are sort and/or found.

For the GMMDC, the offline technologies of the TouchTutor® and the Mathematics CAPS aligned interactive digital teaching-learning resource materials became the solution to some of the challenges of online technologies (Olivier, 2016). The TouchTutor® enabled the integration of ICT support in education (Olivier, 2018). However, the TouchTutor®'s use of offline technologies and resource materials represents a Techno-Blended approach rather than a blended approach which always include the use of online materials (Olivier 2018;). The techno-blended approach is thus the newest strategy of addressing the challenges in Mathematics education.

Teaching Mathematics is challenging for many Mathematics teachers (Botha *et al.*, 2018). However, the incorporation of ICT can lessen the challenges. Mathematics can be made more accessible and meaningful by the integration of the Mathematical concepts' verbal language with different media (Botha *et al.*, 2018). The different media include amongst others, the still and dynamic media, with dynamic media distinguishable into interactive media of applications and software packages and non-interactive media of animations and videos (Holzinger *et al*., 2008).

Self-directed learning in Mathematics is an important educational goal (Bolhuis, 2003:327), and a requisite skill for the active, critical and creative thinking and learning promoted by the DBE through the NCS. Knowles (1975) described self-directed learning as a process by which a learner makes an effort, with and/or without the assistance of others, to determine his/her learning needs. Afterwards he/she formulates his/her learning goals, identifies the appropriate resources for his/her learning, before choosing and implementing his/her learning strategies and evaluating his/her learning (Knowles, 1975).

METHODOLOGY

A QUAN-qual survey on the TouchTutor® experience was administered manually to seventy five (75) King Williams Town secondary school learners in 2018. Fifty one (51) grade 11 and twenty four (24) grade 12 Mathematics learners from 18 secondary schools participated in the survey. The learners also gave general comment(s) on their experience of using the TouchTutor® package. These selected learners with Mathematics potential and interest were identified and selected by the GMMDC in collaboration with the Eastern Cape Provincial Department of Education, Sports and Culture. They were also selected based on a standardised pre-test and historic school based results in Mathematics.

Every learner accessed paper-based survey and responded to the five (5) research questions bulleted in 1.1 above. The five (5) sub-questions a) - e) of the first research and survey question were answered by choosing one of the five (5) options of a Likert-scale choice items of "strongly disagree, disagree, neutral, agree and strongly agree". The choice answers for the second, third, fourth and fifth bulleted research and survey questions were given as indicated in the results of the respective questions in 5.2-5.5 below.

RESULTS

- For reporting the TouchTutor® impact on self-directed learning (SDL), the "agree" and "strongly agree" responses were combined in answering the first research and survey question. This created opportunity to use pseudo-statistics to rate the impact linked to each Likert item.
  The following percentages of learners credited the TouchTutor® and Mathematics resource -

	Research sub-questions	**% (raw total out/whole)**
(a)	for motivating them to do more school Mathematics on their own (than before);	**89.33%** (67/75)
(b)	for making school Mathematics more accessible and enjoyable to do	**84%** (63/75)
(c)	for inspiring them through the personal ownership of and access to the TouchTutor® and Mathematics resources	**92%** (69/75)
(d)	for sharing knowledge with fellow learners much more easier	**90.67%** (68/75)
(e)	for being more actively involved in Mathematics than ever before	**83%** (62/75)

- The following percentages of learners reported access to and use of the specified TouchTutor® resources between the Saturday ISP sessions:

83% (62/75)	**75.67%** (56/75)	**53.33%** (40/75)	**44%** (33/75)	**33.33%** (25/75)
for pdf PowerPoints	for multiple choice tests	for pdf past examination papers	for video lessons	for calculator videos

- The TouchTutor® Mathematics resources were used by the given percentages of learners in the follow manner and/or place:

89.33% (67/75)	**66.67%** (50/75)	**49.33%** (37/75)	**44%** (33/75)	**9.33%** (7/75)
at home alone	at school	with friends	in the classroom (not Saturday ISP classroom)	in public

The rate of accessing the TouchTutor® Mathematics resources was:

52% (39/75)	**29.33%** (22/75)	**20%** (15/75)	**0%** (0/75)	**0%** (0/75)
regularly (more than once a week)	nearly every day	now and then	seldom	never

- The specific number of hours that the TouchTutor® resources were accessed per week by learners was:

No of hours per week	1-2 hours	2-3 hours	3-4 hours	more than 4 hours	less than 1 hour
% access per week	**45.33%** (34/75)	**29.33%** (22/75)	**14.67%** (11/75)	**9.33%** (7/75)	**2.67%** (2/75)

DISCUSSION OF RESULTS

The 83-92% of motivation, inspiration, sharing being, active involvement, accessibility and enjoyment around Mathematics is all good for the dreaded subject that is failed more than any other. An excitement and enthusiasm around Mathematics is generally unheard of and needed more and more to improve the performance in the subject.

The access and use of 83% pdf PowerPoints, 75.67% multiple-choice tests and 53.33% past examination papers is clear demonstration of constant effort by the learners to determine their learning needs, formulate learning goals and use the supplied TouchTutor® learning resources as learning strategies and evaluation tool as well.

CONCLUSION

The TouchTutor® Mathematics resource package is an innovative, powerful and relevant 21st century tool to support the SDL of learners, especially outside the normal classroom. Learners were more motivated, more engaged with the curriculum material than ever before. They were more inclined to collaborate with peers and inspired as a result of the introduction of the techno-blended support model that made Mathematics accessible and enjoyable. The accessing and use of different resources at different places between the ISP sessions regularly, on a daily basis, for an average of 1-3 hours per week, is further sign of learners' constant self-directed learning.

The average final Mathematics marks of both the Grade 11 and the Grade 12 ISP learners also improved between 2017 and 2018. This confirms the great potential of the Tablet & TouchTutor® with the ISP model to result in improved NSC Mathematics results in under-performing public schools in many parts of South Africa. This Techno-blended approach should be considered for use by the DBE in many more schools throughout South Africa in the near future.

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